- The Gyrokinetic Regime
- Geometry
- Velocity Space
- Linear How-To
- Units
- Non-Linear Issues
- Miscellany

- Step-by-step walk-through of `s1.in` from Examples section of website, with transformation to Cyclone base case and comments.

- Nothing to change here; looks good.

```
&collisions_knobs
collision_model='default'
/
```

- Very much smaller values of `phiinit` okay, even though screen output looks odd because of round-off. Wait long enough and obtain usual results.

```
&init_g_knobs
ginit_option= "noise"
phiinit= 1.e-5
/
```

- Appropriate choices for linear runs

```
&dist_fn_knobs
boundary_option = "default"
gridfac= 1.
/
```

- This only changes for theoretical studies.

```
&source_knobs
source_option="full"
/
```

- This never changes.

```
&fields_knobs
field_option= "implicit"
/
```

```
&gs2_diagnostics_knobs
print_line = T, write_line = T, write_omega = T, write_omavg = T
write_eigenfunc = T
write_final_fields = T
nwrite= 10
navg= 100
omegatol= 1.0e-3
omegatinst = 500.0
/
```

- From s1.in:

```
&parameters
beta = 0.003
zeff = 1.000000
/
```

- For Cyclone base case:

```
&parameters
beta = 0.0
zeff = 1.0
/
```

- Good typical choices here:

```
&le_grids_knobs
ngauss = 5
negrid = 16
ecut = 6.0
/
```

- Choose a range of k values for the calculation.

- Defines $v_t \equiv \sqrt{T/m}$

```
&kt_grids_knobs
grid_option='range'
norm_option='t_over_m'
/
```

- Choose a set of k values for the calculation.

- Defines $v_t \equiv \sqrt{T/m}$

```
&kt_grids_knobs
grid_option='specified'
norm_option='t_over_m'
/
```

- For s1 case, equally spaced poloidal wavenumbers, all with $\theta_0 = 0$:

```
&kt_grids_range_parameters
naky = 8
ntheta0 = 1
aky_min = 0.1
aky_max = 0.8
theta0_min = 0.
theta0_max = 0.
/
```

- For Cyclone case from web, need set of 9 k's.

```
&kt_grids_specified_parameters
naky = 9
/
```

- Need nine namelists like this:

```
&kt_grids_specified_element_1
aky= 0.02
/
&kt_grids_specified_element_2
aky= 0.04
/
```

and so on.

- Both are electrostatic cases

- Time step can be larger for Cyclone case

```
&knobs
fphi= 1.0
fapar= 0.0
faperp= 0.0
delt = 0.05
nstep= 1000
/
```

- s1 had two species:

```
&species_knobs
nspec= 2
/
```

- Cyclone has one kinetic species:

```
&species_knobs
nspec= 1
/
```

- s1 case:

```
&species_parameters_1
z = 1.0
mass = 1.0
dens = 1.0
temp = 1.0
tprim = 5.0
fprim = 1.0
uprim = 0.0
vnewk = 0.0
type = "ion"
/
```

- Cyclone case has different R/L_T and different R/L_n:

```
&species_parameters_1
z = 1.0, mass = 1.0 dens = 1.0,
temp = 1.0
tprim = 6.9
fprim = 2.2
uprim = 0.0
vnewk = 0.0
type = "ion"
/
```

- Only needs to appear in s1 case; okay to leave in for Cyclone case (no effect)

```
&species_parameters_2
z = -1.0
mass = 2.72e-4
dens = 1.0
temp = 1.0
tprim = 5.0
fprim = 1.0
uprim = 0.0
vnewk = 0.1
type = "electron"
/
```

- May not need empty namelists; under development (but should work – question is the odd platform)

```
&theta_grid_file_knobs
/
```

Implicit Algorithm Automatically Recovers Low Mass Approximation

- Consider relevant terms:

$$\frac{\partial f}{\partial t} + v_{\|}\frac{\partial f}{\partial \theta} = \mathcal{S}$$

- Centered, implicit time and space differences:

$$\frac{f_{j+1/2}^{n+1} - f_{j+1/2}^{n}}{\Delta t} + v_{\|\,j+1/2}\left(\frac{f_{j+1}^{n+1/2} - f_{j}^{n+1/2}}{\Delta \theta}\right) = \mathcal{S}_{j+1/2}^{n+1/2}$$

where $f_{j+1/2}^{n+1} \equiv \frac{1}{2}\left(f_{j+1}^{n+1} + f_{j}^{n+1}\right)$ and $f_{j+1}^{n+1/2} \equiv \frac{1}{2}\left(f_{j+1}^{n+1} + f_{j+1}^{n}\right)$.

- Leads to an upper diagonal system, easily inverted.

- Trapped particles and parallelism made easy by homogeneous, inhomogenous sweeps in spatial coordinate j.

- For large Δt and simple source

$$\mathcal{S} = v_{\parallel j+1/2} \left(\frac{\Phi_{j+1}^{n+1/2} - \Phi_{j}^{n+1/2}}{\Delta\theta} \right) F_m$$

  the solution is easy:

$$f_j^{n+1} = \Phi_j^{n+1} F_m$$

- Electromagnetic source give $\frac{\partial A_{\|}}{\partial t}$ contribution.

- In general, one finds

$$f^{n+1}(z) = \int^{z} \frac{dz'}{v_{\|}} \left(\frac{\mathcal{S}^{n+1} + \mathcal{S}^{n}}{2} \right)$$

  so that this scheme has recovered the bounce (or orbit) average when $\Delta t > t_{\text{bounce}}$.

- As the amplitudes get large enough to limit the time step, the correct non-bounce-averaged response is recovered. *No subsidiary ordering of the nonlinear terms is required.*

- Centered values are 0.5, 0.0

- Linear results should be independent of these choices.

- Presently must specify values for each species.

```
&dist_fn_species_knobs_1
fexpr = 0.4
bakdif = 0.0
/
```

```
&dist_fn_species_knobs_2
fexpr = 0.4
bakdif = 0.0
/
```

- s1 choice:

```
&theta_grid_knobs
equilibrium_option='eik'
/
```

- Cylone choice:

```
&theta_grid_knobs
equilibrium_option='s-alpha'
/
```

- s1 geometric parameters (local equilibrium model) :

- Note that evidently $a_* = a$ in this case.

```
&theta_grid_parameters
ntheta = 32
nperiod = 3
rhoc = 0.1, Rmaj = 3.0, R_geo = 3.0
qinp = 2.0, shat = 1.0, shift = 0.0
akappa = 1.0, akappri = 0.0
tri = 0.0, tripri = 0.0
/
```

- Cyclone geometric parameters (shifted-circles model) :

```
&theta_grid_parameters
ntheta = 32
nperiod = 2
eps = 0.18
epsl = 2.0
pk = 1.43
shat = 0.8
shift = 0.
/
```

```
&theta_grid_gridgen_knobs
/
```

- s1 case:

```
&theta_grid_eik_knobs
itor = 1, iflux = 0
irho = 2
ppl_eq = F, gen_eq = F, vmom_eq = F, efit_eq = F
local_eq = T
eqfile = 'dskeq.cdf'
equal_arc = F
bishop = 1, s_hat_input = 1., alpha_input = 1.643
delrho = 1.e-5, isym = 0, writelots = F
/
```

- Cyclone case:

```
&theta_grid_eik_knobs
/
```